General Science Quarterly

Vol. IV MARCH, 1920 No. 3

The Relation of General Science to Biological Science in the Secondary School *

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Professor Twiss in his "Science Teaching" has pointed out that Thomas Henry Huxley in 1869 presented a general science course in the form of a series of illustrated lectures to the children of London. This course was later published as Huxley's too little known book entitled "Physiography." The core around which this course was built was the environment of the child, and from that the great teacher worked outward toward the things more remote to the child's comprehension. The inductive approach, of which Huxley was the master, lead the child to the final grasp of the subject in a way that the formal method of pure deduction never could do. And yet, Huxley, who was a master teacher, was not afraid to tell where telling was of use, nor did he avoid the method of deduction where he found use for it. He taught with a purpose, and as we now realize, with prophetic vision. His methods have become recognized as the most fruitful of results from the standpoint of interest and aim.

Huxley called science "organized common sense." As we know, it shows the necessity of first hand evidence. Educators are beginning to realize the importance of starting a child early in habits of straight thinking. Many of the difficulties of the present day could be avoided if people had the habit of demanding truths or facts and not hearsay as evidence on which to base arguments. Examples of such misuse of false information on which to base arguments are seen in our debates on the "League of Nations;" on the rights of operators and miners, and on the status of Bolshevism. The Bolsheviki base perfectly logical arguments on untruths and thus logically argue to false conclusions. If science in the elementary and second-

*Given before the annual meeting of the Biological Round Table of the Minnesota Educational Association at Minneapolis, Minn., Nov. 7, 1919.

ary schools can not turn the minds of future generations to straight thinking then it has lost its primary purpose.

Arguments which state that children from eight to fourteen cannot reason are becoming proven false in the life of our modern psychological tests. It is the Morons, or low mental types whom we push along from grade to grade who are not able to reason. Now that we have machinery established for the segregation of low grade mental types and also the segregation of eye and ear defects, we have done much toward solving our teaching problems.

We are all familiar with the so called method of science. Its five steps are first, the arousing of interest in a problem and its location. This suggests possible solutions of methods of attack. The second step gives us a comparison between the projected problem and the work of others. Then comes the third step, that of the experiment or testing. This leads us to tentative conclusions. Our final step leads us to the verification of the problem and the acceptance or rejection of our results. A classical example of the working of scientific method has been shown in the proof that malaria is carried by the Anopheles mosquito. As early as 1880, Lacaran in Algeria, and Golgi a little later in Italy found a parasite in human blood which they believed to be the cause of malaria. In 1894 Sir Patrick Manson gave out his theory that some blood sucking insect carried malaria. Major Ross, then stationed in the Indian army, accepted Manson's theory and went to work to verify his beliefs. We all know how for two years he examined thousands of Culex with negative results. We remember how by chance he examined an Anopheles mosquito and found the tiny black specks in the stomach walls which gave him the clue which led to the final solution of his problem. His splendid perseverance, and his belief in the theory of Manson brought him to the complete working out of the life cycle. But the world was not ready to accept Ross's conclusions. The final verification was brought about by experiments in widely different localities. First, Grassi, working with his screened laborers near Salarno, Italy, proved that no malaria was taken by the screened laborers. Then came the group of English physicians working in the most malarious district on the Campagna, only taking the precautions of screens and gloves, and thus escaping malaria. Finally the positive proof by young Dr. Man-

son, son of Sir Patrick Manson and Dr. Warren, both physicians in London. They allowed themselves to be bitten by mosquitoes which were known to have bitten malarial patients in Italy. Positive proof came when they came down with malaria. This is only one of the thousands of problems solved in recent years by the methods of science; problems which have gone far to make this world in which we live a better and safer place.

Living things, man included, live in an environment which is made up of certain definite factors, and with these factors living things react and interact. Some of these factors are materials—things; others factors are forces. The ultimate result of the complex we call life is the interaction of the materials and forces with the living things on the earth. Man, however, is supreme among animals because he alone of all the animals can control the factors of his environment. He does this, not by migration as do the birds and fishes, nor by hibernation like the bear and woodchuck, but by actual change or improvement of his environmental conditions. When cold, he lights a fire or wears warmer clothing or takes a trip to a warmer climate. He alone of all living creatures has control of fire and water and electricity. He only of other living animals has come to use artificial light. His home has evolved from the cave of primitive man to the complex housing systems of the present age. His communal life has brought with it new problems—the disposal of wastes, the safeguarding of water and milk supplies, the need of community sanitation and hygiene. His higher civilization demands use of machines, the need of which his forefathers neither knew nor felt; of transportation and communication; of more varied and practical education as well.

Do you ever stop to think that we are living at a time when science has done more to make every day life comfortable than at any other time in the world's history? We sleep at night in a bed, the springs and parts of which were made by machinery, and the covers of which were woven by complicated processes; we wash with soap made by chemical formulae and mixed in a factory full of complicated machines. We eat prepared breakfast foods, and cook on gas, coal or wood stoves made by machines. Every part of our waking and sleeping hours in some way comes in contact with machines, and yet how few of us actually know very much about the science which underlies all

of these and many other useful and beneficial inventions. Have you ever thought of some of the things which have come to be thought common since the fathers and mothers of the children we teach were born? X-rays, radium, the pianola, liquid air, submarines, gas engines, sky scrapers, harvesters, vacuum brakes, fireless cookers, vacuum bottles, vacuum cleaners, color photography, smokeless powder, electric locomotives and street cars, airplanes, hydroplanes, motor cycles, gas mantles, automobiles, carpet sweepers, asphalt paving, safety matches, pneumatic appliances, moving pictures, typewriters and adding machines, wireless telegraphy, pneumatic mailing tubes, electric heating and cooking apparatus, turbines, paper towels, electric lighting, reinforced concrete, sanitary drinking fountains and cups, and a great many other things which we have come to look upon as almost necessities of life.

In the midst of such a life as this our children are growing up. Science beckons to them from every side. In every device used at home for comfort and better living, science speaks. The telephone and telegraph, the trolley and the automobile, the airplane and submarine, have all become part and parcel of their daily lives. And yet living in touch with these wonders of science, relatively few boys and girls understand even the simplest of such inventions. Many of the wonders of this age of science cannot fail to interest the average boy or girl if he or she is made to see just how this or that particular scientific mechanism affects them directly. Children of from twelve to fifteen years of age have interests that are usable in the classroom, providing such interests are properly directed, and although the interests of boys and girls may differ, yet there are wonders enough for all, and things may be found that are vital to both of the sexes. For in any scheme of modern education we must take individual differences into consideration. We no longer educate in the mass. Sex, age, environment, capability, heredity, all are important factors which must be recognized by the modern teacher as having a place in educational practice as well as theory.

Since we must allow for individual differences in our scheme of education, it goes without saying that mass education, which does not account for the child as a personality, can no longer be admitted as a part of our scheme. We must take cognizance of all the factors mentioned in the last paragraph. Environ-

ment, age and sex, act more or less uniformly and thus may be taken into account in the forming of classes or groups. But individual capability and endowments, heredity's part in the game of life, are much more difficult factors with which to deal. Recent developments in educational psychology show that one method of attack, however, has certain elements which may be used successfully with any group of children not too young to think to a conclusion. Problem solving of one sort or another is common to all activities of life. It is the one great factor which goes toward making for success or failure in life. It should be part of the mental attitude of every educated person. The girl who dresses her doll and the boy who rigs his sail boat are directly working toward the solution of a problem—a something to which she or he deems worthy of directing all their attention and interest for the moment. When in the course of the ultimate solution of such a problem it becomes necessary to solve several minor problems in the attempt to reach an ultimate goal, a goal which in his or her mind is an accomplishment worth while, then the entire series of problems becomes a project. Differentiation might be made between problem, experiment, and project. Problems should be presented at the beginning of the lesson or science unit as the salient points around which the thought of the lesson period centers. Thus the pupil may orient himself at the start. A problem may be explained by an experiment; it may conceivably be an experiment or it may require a logical series of experiments to explain it, or it may not be an experiment nor make use of the experimental method per se. The use of the term project by Professor J. A. Stevenson of the University of Illinois is a good one. He conceives the project as a problematical act carried to its completion in its natural setting. Thus a project may conceivably be a problem but it must be self imposed and worked out toward a *practical end* in the natural environment of the pupil. Problem or project, call it what you will, it represents the method by which things worth while in life are achieved. It places a method in accomplishment of those things in life which mark greatness from mediocrity—the leader from the led. It is the logical outcome of the pragmatic philosophy of the pupil and of the age in which he lives.

Problem solving is a part of every successful life, therefore

the method of project teaching has much to recommend it for individual treatment. It is needless to say that a project which might appeal to one child may not appeal to another. It is also certain that the factors of age, sex, heredity, and environment have a part in determining the reaction of a given child to a particular project. Boys may be interested in projects connected with the application of certain mechanical principles in machines; in the use of electricity in its many forms, in the conquest of the air by means of the airplane or dirigible. Girls on the other hand naturally create problems involving questions of home economics, chemistry in the home, or home gardening. The environment of the individual is bound to influence the nature of the project as well. What city bred girl would be interested in butter making from a science standpoint, and how many city boys would become wildly enthusiastic over the project of crop rotation for the farm? In our teaching as well as in our use of textbooks we must bear such factors in mind.

We hear a good deal nowadays about the logical vs. the psychological approach. No teacher, and the term is used in its truest sense, can teach except from the viewpoint of the child. And if from this angle then the psychological approach becomes logical. We must have a plan, but we must remember that a plan may be broken to advantage sometimes. And above all we must be human. If we but remember how we looked at things with the eyes of 13 instead of those of 43 we will have no difficulty in solving the method of lesson attack. And we must remember too, that concepts *grow* and are not always brought to maturity in one lesson. The cyclic treatment of topics is a far more natural method of acquiring information than a dogmatic statement, made perhaps with proof but dimly comprehended and soon forgotten.

Any course in introductory science should first of all keep in mind the facts we have just mentioned. It must contain enough of the basic material from which the interpretation of the common things of interest in life may be gained, but it must be prepared to start the individual boy or girl whose interest has been awakened along the line in which the interest naturally flows. Most of all a course should interpret to the child the part played by the various natural factors in his environment. It should conceive the child as the center, and all

the world of the child revolving about this center. In this conception boys and girls would first become aware of the vital part played by air, water, light, heat, and food on them as individuals within their homes. This much is common to all—the application of certain of the general facts learned could then be carried out as special projects by various pupils interested. Logically after the child has learned the meaning of these central factors in the home the next step would be the application of the forces of nature by man in communal life. His control over the primary factors is complete, and, with the progress of civilization, has come a control of the primary environmental factors that children must come to recognize as the hallmarks of civilization. The enormous strides that science has made within the past two or three decades cannot but give rise to hundreds of projects, each of which is more or less directly related to some one of the original few projects rising out of an understanding of the primary factors of the environment and applicable directly to the child's place in the community. Thus children, if given a rational point of view, will have enough and varied interests to work toward the solution of such things in science as seem most worth while of them as individuals and most worthy of themselves as future citizens.

The sequence of science in the elementary and secondary schools should, therefore, receive our careful attention. With the reorganization of the school curricula and with the introduction of the junior high school a very serious problem is placed upon the high school teachers of science. If the junior high school is organized on the so called six, three, three plan, undoubtedly general science, with a broad and elastic treatment of science problems, should come in the first two years of the junior high school, followed by elementary biology in the last year. This would allow in the senior high school more intensive courses in chemistry, physics, with applied sciences coming in the last year. I would appeal for the introduction of more social science, especially would an elementary course in sociology be of real value in the last year of high school. In the four-year high school the plan would be somewhat modified. Here we would expect to find elementary science occurring the first year followed by a year of general biological science. The last two years of high school would

then give option for chemistry, physics, and applied social science. But in no case ought a pupil to pass through the junior high school and senior high school without having a broad foundation of science with some aspect treated in each year of his course.

Since the social side of elementary science ought to be emphasized probably the most effective treatment would be in two cycles. The first cycle should be based on a knowledge of science in the home and its immediate environment; while the second would take up communal life in its relation to science. Science of the home might well include the following topics in approximately the sequence given; the essentials of an ideal home, its natural resources, including treatment of the hygienic demands for pure air, water and food; the proper removal of wastes, the elimination of household pests, and the danger from germs. A cycle of work with projects on heat in the home including the various heating systems, fire prevention and the uses of clothing might follow. Then would follow an elementary treatment of lighting, artificial and natural, with emphasis on the care of the eyes. Home construction and decoration, planning the home grounds and work with home gardens are projects which naturally follow. Science as it works through the various simple machines of the home including the use of electricity, might there be treated. The first cycle might well end with the relation of science to various forms of recreation such as kite making and flying, boat building and sailing, making of motors and airplanes, etc.

The second year of work might well begin with discussions of the ideal community in its various phases and the factors which make it a good place to live in. The natural resources of the community should be emphasized including water power, climate and weather. In this relation the work of the Weather Bureau should be studied. This could be followed by projects on the relation of water to food supplies, its sources, and then to the water supply of communities, giving special attention to modern methods of purification. Since our science should be essentially social, a discussion of the organization of city government should be introduced. The work of various departments, especially that of the Health Department, should be stressed. The Pure Food and Drug Act; prevention of disease; quarantine; natural and acquired immunity; the relation

of insects to disease; the disposal of city wastes, and the protection of life and property are all topics worthy of discussion from a scientific standpoint. Here too, is an excellent opportunity for dwelling upon the moral obligations of individuals in society. Our boys and girls are growing up today with far too much emphasis on the material and far too little on the ethical and spiritual needs in citizenship.

City organization leads us naturally to city lighting, and thus to transportation in its various phases. Finally, such a course ought to lead the pupil through practical examples of plant breeding and eugenics to his introduction of biology. The cycle of biological study which should take up the third year of the sequence would not be a course in botany or zoology but would be primarily biology. Function should be emphasized throughout and should concern itself with the outstanding essentials of biology as seen from a sociological standpoint. It must naturally differ as to construction and laboratory methods for it must differ according to the types of community for which the course is given. For no course in biology in secondary schools should have existence today unless it can have direct bearing on the lives of the pupils. By this I do not mean that we should only teach agriculture in a farming district or applied hygiene in a crowded city but we should adapt our subject matter to the needs of the pupils so as to make them better capable of ultimately becoming winners in life's battle, no matter what their place in this great country of ours. Such courses as we have outlined may confidently be expected to do their part in the great problems of Americanization that lie before us in these post war days.

The Role of Laboratory Work in General Science, and the Teacher Training it Involves *

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In the period of world upheaval from which we are so slowly emerging, the American public under stress of necessity has become familiar with many and divers sorts of "substitutes." In the recent sugar shortage there was a near-rebellion in my

*Given before the General Science Section of the Central Association of Science and Mathematics Teachers; Chicago, November 29, 1919.

family over the use of syrup on breakfast foods. Not one of us would allow that there is any substitute for cane sugar. In twenty-six years of training science teachers for secondary schools, I have been unable ever to find any satisfactory substitute for the laboratory in science teaching. The same is true, to, for my methods courses for teachers of general science, youngest of the high school science subjects.

We all have heard of the man who finally succeeded in getting his old horse to live without eating only to have the "critter" die on his hands . I am convinced that without laboratory work of an appropriate kind general science, too, will die! And unswerving as my advocacy has been for years of the claims of general science for a place in the curriculum of the high school, if it be a text subject only, and is to remain that, then in my opinion it deserves to die. In this connection let me say, however, that my notion of what is properly included under the term laboratory work in high school sciences, especially in such a subject as general science, may not be considered wholly orthodox by all science teachers.

You to whom I have the great pleasure of speaking today in this discussion of the teaching of general science *as a laboratory subject*, are able by reason of your positions and standing in the educational world, to exert a powerful influence upon what eventually shall be the manner in which general science is taught. As I view the question of laboratory exercises in general science, it is not so much a matter of any set form of procedure, or of any specified list of exercises, as it is a question of the spirit and general educational purpose involved.

It has long been my belief that aid of a helpful sort is continued to my students during their first teaching experiences in their own schools through use by them in the different sciences of certain carefully prepared manuals as "Laboratory Lessons." These contain matter supposedly suited to high school classes, especially those of the smaller high schools, and are so arranged that much of the instruction of the course as a whole centers in and can be grouped about simple inductive laboratory exercises. These exercises seek to provoke and direct the thought of pupils progressively towards the several teaching ends in view in every lesson. They are not exclusively experimental, but often consist of sets of prepared ques-

tions, of required drawings and descriptions, of various problems and other quantitative exercises. With increasing experience on the part of the teacher, he is expected in due time to become more and more independent of these aids, and able to select matter and organize a laboratory presentation of it in ways more or less original and suited to the instructor and to his teaching conditions. Because of this belief in the worth of laboratory manuals to teachers generally, and believing as I do that manuals are indispensible to those inexperienced in laboratory instruction in high school sciences, I beg your indulgence as I quote in substance only, and somewhat briefly, from an article which appeared in the June number of School Science and Mathematics under the title "The Laboratory Manual—Its Purpose and Contents:"

In visions of what in general shall characterize this best-of-all manuals, certain outstanding features have gradually taken shape.

In the first place, any such manual lends itself to a conception of the laboratory hour *as a study period*. During laboratory time under guidance of the instructor there is possible a methodical and sustained training of pupils day by day in ways of acquiring knowledge which are characteristically scientific, and at the same time not exclusively experimental.

In the second place, before any experiments are worked by pupils, this manual provides that there shall be assembled through questioning, whatever knowledge the pupils possess of the topic under consideration, and that this knowledge be organized around the results of a certain small amount of experimental work *done by the teacher*. Obviously these experiments must be simple, and so chosen that a scientific understanding is secured both of the old and of the newly acquired knowledge. The experiments are designed to arouse and sustain interest, provoke thought, and become centers of new groupings of knowledge. Whether such preliminary discussion requires one period or two, and whether or not it be completed during one day's session, is of far less importance than are the teaching values attained in the time spent in the discussion. To hurry the presentation of scientific fact and theory upon pupils mentally unprepared to receive it, and indifferent because of this unpreparedness, is to defeat the purpose which prompted the haste.

It is both the province and the opportunity of the instructor during this time of introductory discussion to guide it in such ways and to so enrich its content that time spend upon it *constitutes a teaching period of largest possibilities.*

To interpret simply and effectively the many unrelated experiences of pupils, the instructor must be prepared to contribute a large measure of additional information to the end that what is known by the pupils shall have scientific organization and significance. Each succeeding phase in the discussion of any problem then acquires its correct bearings and scientific relationships.

During the time spent in the laboratory in writing up the results of exercises worked out, and in answering questions raised in connection with these exercises, need arises for use by the pupils of texts and reference books in order to satisfy every desire for knowledge more definite and more complete. Here is the time of all times for a training in the right use of the text as a book of reference. There is great educational gain in thus stimulating and establishing that habitual attitude in pupils which leads them to discern clearly just what information is needed, and which directs them in the ways of acquiring this knowledge *at the very time when it is most serviceable to them.* Such training as this "carries over" from school days into all the varied activities of later years. This combined use of books and experimental exercises in teaching secondary school science is far more productive than is their separate and more or less unrelated use.

Certain questions, too, are to be provided in this manual. These seek to anticipate difficulties likely to be experienced later in the text assignments, questions which necessitate a discriminating use of text and reference books in a search for information of a specific character. Such requirements lessen the time spent later by pupils as text preparation for "recitations," for "quizzes," and for "examinations," since some of the more extended discussions of the text thus have been disposed of.

In so far as there is a simple experimental basis for it, the manual fittingly appropriates to its introductory discussions portions, too, of the theories of science. There is little likelihood in any such procedure of a failure to leave for subse-

quent text discussions sufficient difficulties to tax fully both teacher and pupils.

It has been my desire in making as above these rather free quotations from the article in question to emphasize strongly a personal belief that the teaching of elementary science measures up to its possibilities only as its laboratory exercises *are correlating centers for all phases of the teaching process.* This belief amounts to a conviction—a conviction based upon many years of testing in my own work, and upon results known to have been wrought out in teaching done by others. Especially do these beliefs apply in the teaching of general science. As a science subject, taught without well-defined and well-sustained laboratory features, general science fails to function properly in public school education.

The laboratory manual should direct a teaching procedure in which instruction is combined with an experimental presentation of the topic studied. These features must be so inextricably interwoven that teachers inexperienced and ill-prepared cannot go far astray in their teaching, and then only after much the same degree of difficulty experienced by the Senators at Washington in disentangling the League Covenant from the Treaty of Peace.

Do not misunderstand me! You to whom I am speaking may be wholly independent of any need to follow laboratory manuals as published unless it be as time savers in laboratory administration. Trained science teachers of long experience in large city systems can well be left to choose and combine and use successfully material of their own for science courses. Their laboratory problems are of a different nature. But let it not be that we who are earnest advocates of the worth and excellence of general science in high schools be blind to the fact that the future of this subject as an integral part of public school courses is largely in the hands of high school teachers lacking your experience and fitness for teaching—teachers to whom the role of effective laboratory work in elementary science teaching is yet a matter of discussion rather than of performance. Of the thirteen thousand high schools in the United States reported by the Commissioner of Education for 1914, over ten thousand of them are schools with four teachers each, or less. Relatively very few high schools employ special teachers for the different science subjects. In many of the

smaller high schools the untrained unprepared "science teacher" faces teaching conditions suitably characterized as "impossible."

We are not altogether hopeless of the coming of a time when general science shall be taught by those only who are especially prepared to do it, and who have the all-round teaching skill so necessary to meet successfully its teaching difficulties. But we have to confess that to our certain knowledge there are yet many things in connection with science in the public schools over which we as science teachers lack control, not least of which is power to say *who shall not teach science in high schools.* As a matter vital to the future of general science, its advocates can insist that its teaching on any basis other than laboratory exercises is to invite failure generally with promise of success only when in the hands of the relatively few exceptionally capable teachers, those likely to succeed in the teaching of any subject. The instruction given should follow such a procedure that the average teacher in the smaller high schools need not make a failure of general science, but rather make a great success of it. There is need of a manual calculated to serve general educational ends as well as the special purposes of a scientific presentation of topics included in a course in general science. Publishers will, I believe, be glad to provide such manuals when any considerable demand for them is voiced. The problem under discussion is made doubly difficult by the fact that in the small high schools there is an endless round of changes in the teaching force, and teaching efficiency *through experience* is little in evidence.

For seven years now I have been giving in the Teachers College of the University of Nebraska "methods courses" in general science, repeated the first and second semesters and in summer session. These classes of prospective teachers have averaged twelve or more, but there is no sufficient reason for believing that these students with their limited special preparation have all taught general science. It is reasonably certain that few of them have continued as "science teachers" through many years. The School Directory issued by the State Superintendent of Nebraska for the year 1918-19 names 380 high schools employing four or more teachers. Of these 250, or 65% of them, reported to the office of the Inspector of

Accredited High Schools courses given in general science. This means that *in seven years time* I have had about as many students in my two hours methods course in general science (241) as there are schools in which the subject is being taught. Now I do not flatter myself that any school board has waited seven years in order to get one of these teachers. The total number per year of prospective teachers of general science from all the teacher training agencies of the State is pitifully inadequate to meet the needs of the public school system.

Speaking in general terms, and without data to verify the statement, the common procedure in general science as taught in high schools is to require pupils "to recite" upon text assignments, with laboratory work lacking entirely, or merely incidental and spasmodic in character. It seems safe to assume from knowledge at hand that a large majority of those teaching general science in the smaller high schools have neither had any sufficient preparation for this very difficult teaching, nor do they intend to continue teaching the subject and thus become proficient through practice. In many cases, so I have reason to know, general science is assigned to a teacher in spite of her protests of unfitness to give instruction in it, and of an unwillingness to undertake it. The subjects of the curriculum are "divided up" among the members of the teaching force, and the person making least protest gets general science. I have more than a suspicion that similar conditions may be found elsewhere than in Nebraska, possibly in the communities and states from which some of you come. Wherever such conditions are found, there is warrant for a note of alarm over the future of general science. There may come a time when advocates of this subject will be called upon to show cause why it shall not be dropped from the curriculum of the high school owing to lack in educational values attained. The introduction of general science into the high schools of the country has been so rapid as to be a joy to its advocates. It may be it would have been as well if its introduction had been slower. If reasonably well taught, its permanence in high school courses is assured. But continued lack of any laboratory basis for instruction in it, and lack of teachers sufficiently well prepared to give this instruction, may even yet turn the tide against it.

It can be taken for granted that teaching success in the

sciences as in other high school subjects involves an ability on the part of the teacher to secure well-sustained efforts on the part of pupils in satisfying the normal human desire to learn *whatever is worth knowing.* The greatest of all teaching difficulties encountered in the elementary aspects of the sciences does not inhere in the subject matter, but lies in the "human element" involved in the teaching process, lies in the boys and girls under instruction who all too often are indifferent and sometimes antagonistic to a teacher's efforts. Advocates of general science have won for the subject a permanent place in the high school curriculum *on the ground that it is based upon broadly educational rather than strictly scientific lines.* While inevitably it is introductory to later courses in the differentiated sciences of the high school, such is not its chief purpose. Whatever is of largest educational advantage to the boys and girls under instruction, providing it is germane to discussions of the phenomena of natural science, dominates all other considerations. The selection of matter, and the manner of its presentation, should take into account first and all the time the intellectual fitness of pupils as the men and women of tomorrow. Here, too, is ample warrant for an enrichment of its discussions by consideration of the applications of science to social and economic welfare. And we take occasion right here to express the hope that the time may never come when this course of the secondary school curriculum shall lose the flexibility it now has, and teachers their freedom to adjust its matter and method to fit widely varied teaching conditions.

Any discussion of our subject restricted to the two items (1) a supply of suitably prepared teachers for general science, and (2) their presentation of the subject upon a laboratory basis, is incomplete. For it is short-sighted ever to expect in the smaller high schools of the country teachers trained for general science alone. Nor would this be desirable. While in Teachers Colleges and in Normal Schools there properly is a "special methods" course in general science, the preparation of teachers for this subject should by all means include at least enough of the elementary phases of other high school sciences so that in the smaller high schools the teacher of general science is the "science" teacher in the corps of instructors. Preparation for this teaching of "high school science" should

be extensive rather than intensive, making any suitable preparation of science teachers for small high schools especially difficult.

In the aggregate a large number of young men and young women who have been in my classes have later taught science in the high schools of Nebraska, and in adjoining states. The teaching conditions encountered by them in the various schools, and the various factors personal and otherwise likely to determine their success or failure, have been matters of inquiry, of observation and of personal concern. The needs of the smaller high schools for closely correlated science courses effectively taught, and the aptitude manifested by those anxious to qualify for this teaching, have ever furnished me an incentive for sustained efforts through many years in seeking a greater teaching efficiency in the high school sciences.

During these years of my teacher training experience profound changes have occurred in the character of science teaching in the schools of Nebraska as elsewhere the country over. There has been great increase in the number of high schools, in the number of science teachers needed in them, in the extent of laboratory courses, and in the equipment for such courses[1]. The aims of high school science teaching have undergone great changes, too. No longer is one who has "specialized" in some one of the sciences, *e. g.*, in chemistry or in physics, considered as sufficiently fitted thereby to meet the varied demands made upon him *as the science teacher in a small high school.* Demands made by school boards often amount to an unqualified insistence for teachers who possess general knowledge in all the fields of science, a knowledge which though elementary is definite, unified rather than differentiated, and closely related to the social and economic life interests of the pupils taught. The demand is for ability to aid high school boys and girls to acquire such understanding of the phenomena of their natural environment as developes in them an habitual attitude characteristically scientific.

Whatever money can buy in the way of furnishings, books, etc., is available in these days in almost every community for use by science teachers of proved competency. But so far as the smaller high schools are concerned, teachers of high ideals

1 The High School Situation, Woodhull, in General Science Quarterly of March, 1917.

and large aptitude, and who at the same time are masters of the purposes and procedure of laboratory science suited to beginners, would seem lamentably scarce in our American public schools. This in no sense warrants any relaxation in effort for meeting the needs of these schools in every way possible, nor does it justify a return to the discarded plan of attempting to meet these needs by certification of those who have specialized in some one science, and then have added to this academic preparation a few "courses in education." Bitter educational experience has taught the futility of this solution of the problem of providing science teachers for the smaller high schools.

Throughout this discussion which now must be drawn rapidly to a close, I have purposely avoided consideration of the peculiar problems confronting teachers of general science in the large high schools where sections of maximum enrollment occupy all the time and resources of special teachers. Despite the amazing total of pupils in the large high schools of the country, and the necessary modifications in procedure to handle the crowded classes in general science in these schools, there is at least some large degree of permanency in the teaching force of such schools. But failure here to teach general science upon a laboratory basis, whether of the standard type of such special sciences as physics and botany and chemistry, or the greatly modified and simple procedure suggested above in connection with the characterization of laboratory manuals, invites the same condemnation and rejection of general science in the curriculum of the large high school as in the smaller one. Whether or not experiments are performed exclusively by the instructor as each topic is taken up in turn, and whatever may be the combination of experimental work, discussion, study, and written efforts, it is possible for teachers of general science in large high schools as in small to develop, to direct, and to habituate pupils to the spirit and procedure of laboratory sciences. The worth of this training easily transcends the informational values of the course, however great these may be.

We who are especially concerned with the future of general science can well afford to unify our aims in our various fields of endeavor, though our procedure in attaining them may have little in common. Diversity in method is wholly compatible

with unity in aim, and nowhere in school work more so than in general science.

And now in closing may I say that I am ever impressed with the sanity of a demand that he who theorizes in education, and who undertakes to formulate its principles or to present for consideration any philosophy of education, may very justly be required at the same time to specify by what course of action this theoretical shall become practical, establishing his right to a hearing by reason of evidence of success in an application of his beliefs. That architect alone is great whose visions take form in drawings, plans and specifications, and eventually in enduring structures of stone and steel. My belief based on experience is that the views presented in connection with this discussion of the "Role of the Laboratory in Teaching General Science" will stand the test of application. Too much of enduring value has been hard won for general science in the field of public education to warrant risking loss of what has been won. Can we not unite in insisting that in all general science teaching there shall be the spirit, the procedure, and the values of experimental science.

An Experiment in Teaching Sciences.

CLARA H. WILLIAMS, High School, Skowhegan, Maine.

Teachers of science are not afraid of experimenting and trying new methods. The GENERAL SCIENCE QUARTERLY for May 1918 tells us "Now is the golden opportunity for change which comes with every cataclysm of life" but in making changes in our teaching we should be sure to hold fast the good already attained,—the fine devotion of our teachers, the excellence of our modern text books, and the scientific spirit of our laboratories. More than two years ago there came to my mind what seemed to me to be a new method of teaching which works in well with all the good methods we may use and helps us to do a little more easily and a little more quickly the things we have always aimed to do.

This method includes a new way of preparing the lesson, a way of reciting which is more than hearing a lesson and a drill which may be used to take the place of much of the usual test work. Any teacher can use it for any class with any text book. It will increase enthusiasm and insure understanding.

The following outlines the method as we have used it for three years' work in chemistry and science.

I. Preparation with questions (usually done outside class)

II. Class work

1. Supervised Study (Discussion among the pupils)
2. Recitation (Topics and Answers)

III. Summarizing the Work (Drill)

In one recitation period you may make a test of just what this method will do. For this, select from your text book two or three pages and prepare topics and answers covering what seems to you the essentials of these. You may have these hectographed or the pupils can make their own copies when they are ready to use them. When the class meets direct the pupils to make out questions (I) such as, if answered satisfactorily to them would give the essentials of the lesson. The class is then arranged in pairs and quietly ask each other their questions (II). Each pupil is given a slip of paper which he prepares with the name of his partner and numbers corresponding to his own questions. He checks those questions which are answered satisfactorily and signs and passes in the slip together with his questions.

After the class discussion among the pupils, comes the recitation with topics (II—2), one for each paragraph given in the text, placed on the board by the teacher or some member of the class. The pupils, going to the front of the room and facing the class, recite on each paragraph in turn until the lesson is finished. With the command of the information they have gained by the previous discussion they can usually do this easily. Time is not lost because pupils do not listen to recitations. The pupil has something worthwhile to say. He can say it without delay and the interest of the class is already aroused.

You may then give out or dictate the topics and answers (III) prepared beforehand. Allow them to raise a hand when they can give the first, have someone say it, and so on. Then give them a few moments more and ask them to indicate when they can give all the answers. When two are ready they may say them to each other or write them or if you are free they may say them to you.

By timing the pupils on each part of the work, you can make this a speed and efficiency test for the pupils individually and

for the class. The first time we tried this we got these results working on a three page chemistry lesson.

Preparing lesson with questions	15 minutes
	(shortest time 8 minutes)
Reciting lesson to each other	9 minutes
Dictating topics and answers	6 minutes
Preparing drill	4 minutes
Reciting drill	10 minutes
Making in all	44 minutes

When the Freshmen tried this on three pages of science they did as well in time and none got below A on the drill.

On another day the same chemistry class tried another speed test timing themselves on preparing a six page chemistry lesson outside of class and doing the reciting and drilling in class with these results:

Longest time for preparation	40 minutes
Shortest time	19 minutes
Average time	29 minutes

At the beginning of the year they had taken on the average 45 minutes to prepare a lesson, so if they could save sixteen minutes or more than an hour on the four lessons of a day's work their accomplishment seemed worth while.

When I had been using this method for some four months my attention was called to the book, "The Socialized Recitation." This method may be used to lead up naturally to such a departure as this, for it is very easy after the pupil is accustomed to making out the questions and answering them, to have one pupil conduct the class. Besides, there is no danger that they cannot cover the required amount of work if they use this method as there seems to be if they use the method of the Socialized Recitation alone.

After a class has worked for a time this way, the topics and answers may be made out by the pupils themselves. When a chapter is finished, it may be divided among the pupils, each of whom prepares a brief but comprehensive summary of the section assigned to him. These individual summaries arranged in order from a class summary book which we find useful in drills and reviews. The class, too, sees a result of their work. Nothing is done simply to get a mark or to prepare for examination. At the end of a month's work they can

stand up on sides like the old-fashioned spelling school and give in turn all the topics we have had in that time. In chemistry we have made out a similar drill book based on a set of topics made out as minimum essentials by the Association of Chemistry Teachers and have had the summary printed.

To some, the talking of this drill leaves a taste in the mouth like pre-digested food which is not fed to healthy children to produce muscle. However, it is not words we are learning but ideas. When a new subject is taken up, the pupil's work and the class discussion, illustrations and experiments are introduced before the pupil sees the drill answers. Each part of the work remains a project as long as discussion is profitable, when by the summing up of the topics the subject is closed and the attention is given to another. The pupil feels satisfied with what he has done and is more ready for the next subject. With the drill out of the way, there is time for all sorts of pleasant excursions. In chemistry we save time enough to spend two weeks on original projects and at the same time the boys prepared for Yale examinations without extra time outside. Using such a drill need not give undue emphasis to the memorizing of facts but may get the learning of facts out of the way so as to give time for their application.

Every one who has observed this method has seen special merit in the questions and answers by the pupils. Pupils have said, "It makes it necessary for each member of the class to know the entire lesson" and, "Choosing topics helps us in selecting the important parts of other reading." If several seem not to be getting good results this way, we have them recite the lesson in the usual way while the rest use their questions. After that, they usually do all right with the class for they prefer to do it that way. The improvement shown by a class in the way they work with this method is to me the strongest proof of the good it accomplishes.

This method teaches the pupil how to study and how to express himself; it encourages initiative and promotes individuality; it results in the long-desired minimum essentials which may be made the basis for standardizing the work; it relieves the teacher, the class taking much of the responsibility; it gives the opportunity for the laboratory, the text book, and the individuality of the teacher to count for more than ever.

Science and the High School Library

EDITH ERSKINE, Librarian, Harrison Technical High School Branch, Chicago Public Library.

We read a great deal about the High School library and the English department, and the library and the History department, but we find little on the library in its relation to the Science department. Is it because they do not work together or simply that neither teacher nor librarian has told of the work being done? It must be the latter because Science is one of the greatest fields for service in the school.

It is thru Science that the child learns about himself and the world in which he lives, and it is this knowledge that is the basis of living and of learning. Science teachers appreciate the importance of their subject and in teaching it for life's sake, not for its own, they are linking it with other school courses and with the everyday experiences of the child so that it will be remembered, not merely as a school lesson, but will be something to live by and to grow in.

General Science, which is taught in the first year, has not yet an adequate course. The text books alone are not satisfactory and teachers are constantly trying to find new ways to present their subject in an interesting and lasting way and this is the point where the library can begin to do its part. One of the first things of course is to have the books, but before that, it is of the greatest importance for the librarian to know what the teachers have in mind. Right here let me say something about the librarian's reading. That we read library publications goes without saying but that is not enough. A High School librarian should read the periodicals which the teachers read and for which they write. As I said before, we find little about the library and Science but the pedagogical magazines have most interesting articles about the value and teaching of science. Of course they are written from the teacher's point of view, but are not we the teacher's right hand man?

One article I might mention is by Professor Snedden of Columbia and appeared in School and Society a few months ago. He would divide the course in physical science into four parts, one of the parts being Cultural, and managed by having a library of books about volcanoes, planets, tropical animals,

explosives, sub-sea wonders etc. In another number of School and Society the same thought is brought out in an article on the Project method of teaching science, the idea being that text books are, after all, more or less reference books and therefore the real knowledge of the subject should come from books which present science as living projects, and that the students should read as many books in science as they do in literature. The writer goes on to tell that no scientist has ever developed without the reading habit, giving interesting examples. Similar articles have appeared in the School Review and while they are written for teachers, it would seem quite worth while for librarians who are interested in helping the teacher and student, to know what it is the teacher is striving for, what he is reading and thinking and what new schemes are afoot in these days of constant reconstruction. We High School librarians cannot afford to be behind the times if we expect our libraries to be a real force in the school.

To go back to General Science, in trying to find a satisfactory course many schemes have been tried. At Harrison High School in Chicago, a plan of outside reading such as was mentioned in Professor Snedden's article was used last year. One of our General Science men spent some little time in the library going thru the books in each class and making a list of those applicable to his work. The list, about a hundred titles, was posted and the books placed on special shelves for a week, during which time each pupil was supposed to look over several and decide on one to read. The only drawback to the scheme was that the number on the shelves did not remain a hundred for any pupil deciding on a book immediately hid it. We spent most of that week fishing books out from strange hiding places. One book report was required during the semester, extra credit was given for more than one but not for more than three. Extra credit was also given for articles read in Scientific magazines and discussed with the teacher. Three or four themes requiring the use of the library were written during the semester. A similar system was in force at the Austin High School with success. The books were by no means strictly science books, but any interesting non-fiction which was adapted to the work. There were a number of biographies: Thomas Edison, Iles' Famous inventors, etc., books about the movies, aviation, the Rolt-Wheeler books, etc.

In chemistry and physics, of course more strictly technical books are needed and these cost money. We cannot expect to work with the science department and economize on it too. When I first started in High School work, a science teacher remarked that the English teachers thought they owned the library and wanted all the money. Of course that was exaggerated but if there is any such idea it might be perfectly natural. Library people hear more about what they can do in that line, and their training and natural inclinations also carry them in that direction, so they are apt to buy where they are more sure of their ground.

When Harrison was opened, each department recommended books and from their lists the basis of the collection was made, and now except for popular current books, nothing technical is bought without the O. K. of a teacher who knows the subject. In this way our collection is well rounded and our Science, therefore, does not suffer by comparison. One objection to the plan might be that we have much that is too technical for High School use. We have a few things that I might not buy now, but having them, I would not care to give them away. The teachers revel in these advanced books, and while they cannot require their use by the students, they use them in class and with their night school people. In chemistry this is true particularly and it is a great source of satisfaction to have our graduates, who are now attending the University, come back to us for reference work often taking the books home for over Sunday.

As chemistry and economy seem not to go together, the question is what shall we buy? Personally I would not give up our Thorpe's Dictionary which costs $14 a volume, not $14 a set as a fellow librarian I know found out to her sorrow too late, but if I were starting with a very limited amount of money (and most of us do) I would use instead, the New International Encyclopedia which has very satisfactory scientific articles, and spend that $70 on popular chemistry books, such as Martin's Triumphs and wonders of modern chemistry, Sadtler's Chemistry of familiar things, Lassar-Cohn's Chemistry of daily life, etc. The pupils read these so much and they are in such demand by other departments of science that their value is far reaching. Books of this sort should be duplicated freely.

The same is true in other branches of science as the teachers

are all striving for the simply and popularly presented material, which also is the cheapest. At the same time care must be taken to avoid the juvenile. Our students were much insulted to be given Basset's Story of glass for help on their long themes (they are the ones who will use Thorpe.) These very simple books in story form are used by the Freshmen for outside science reading and also for English. At Harrison an effort is being made to link the English more closely with the technical and science work. This is being done by outside reading and by having the pupils use technical and scientific subjects for composition work. A Freshman made the suggestion of classifying these semi-technical books as fiction. He said it was merely camouflaged non-fiction.

If pupils are going to realize that science is a living thing, they must have something more than either technical or popular books. We have studied the War in English and in History, why not in Science? What more important place to talk the War than in Science? Our Readers' Guides and magazines are worn to shreds by pupils looking up topics. They have come to know the Scientific magazines and to know that other magazines have good science articles, and thru this they have learned more of the resources of the library and no longer think of it as a place for just English and History work or merely for story books. One of our Chemistry teachers has required his class to read the articles which appeared in the 1917 Independents for October and November under Creative Chemistry. Each number takes up a different topic—"Coal tar dyes," "Perfumes" etc., written in popular style.

A physiograph teacher in another school makes a great deal of use of the National Geographic. That reminds me of Asia, and that in turn of Commercial Geography. Whether Commercial Geography belongs strictly to the Science department or not, is a question but so far as we are concerned, they use science material enough to be head of it. Our Asia, our Scientific American and Supplement, our Popular Science and Mechanics, and occasional numbers of other magazines are in constant demand. Our Martin's Chemistries, before mentioned, and books on inventions have been used so much they can no longer stand on the shelves but must be allowed to lie down when not in demand. A summer in the bindery we hope will fit them for another strenuous year with many more extra

copies to help out. An interesting feature of the Commercial Geography work is the picture shows which each child gives. Each one is given a topic on which to be prepared and when his turn comes to take the class, he gets his magazine from the library for that period and as he talks on his subject, shows the illustrations with the lantern.

Besides the periodicals to supplement the science books, there is the government material. The botany department in particular use the government pamphlets. While we have Atkinson's splendid book on Mushrooms and use it, we use a small government pamphlet so much more that this year we have purchased fifteen more copies of it. The same class use pamphlets on Wheat and Corn and many forestry pamphlets. So much work is done in Botany the year round, that we perhaps duplicate more freely in that line than in any other, having ten or more copies of Seed dispersal. Blossom hosts and insect guests, and other simply written and inexpensive books. Here we use also American Forestry Magazine, Garden Magazine and the Country Gentleman.

In physiology, we use Good Health to some extent and in Domestic Science, the many good government pamphlets constantly coming out.

An interesting feature of Zoology is the course in Mammals. At that time a six weeks study is made of farm animals. We have a few good books, but as the course is only six weeks, we depend on what we borrow from the Main library. These are used by the teacher with the class and the rest of the time are in use in the library and loaned out for one night. The same is done with the study of birds, fish etc. tho' we have more of those books in our collection.

Agriculture might also be considered as it is really applied science. Here we have the pamphlets again. Before the time of school libraries, the teachers were obliged to furnish and take care of their own material with all their other work, and a teacher of agriculture told me that rather than hunt for a pamphlet thru his great mass of unsorted material it was easier to send and get another one, and it was his opinion that every school, whether it could afford a library or not, should have a trained person who could classify and take care of such material and so help the teacher and student. A library can also get much material that an individual cannot.

In regard to taking care of the material in the library, it has been found that science people are sometimes more confused than anyone else by our classification, so one of the first things we did was to take electricity, 537 and 621.3, from the stacks and put those books all together in a wall case. Chemistry, 540 and 660, followed and now we have all the science, pure and applied, together with a sign over each case: physics, electricity, chemistry, botany, zoology, making it much easier for both teachers and pupils, not to mention ourselves. With this arrangement the teachers are more willing to leave the books in the library instead of each one guarding jealously those for his work in his own room. They have also found that the pupils work quite as well and the teacher is relieved of the responsibility of the books. By keeping the books in the library, more departments are able to use them and the science people also learn more of the resources of the school library. This is being appreciated more and more. In one school the science teachers bring their pupils to the library at the beginning of each semester and show them the arrangement of the books and give them an idea of what is to be expected of them during the year. In another school, the science teachers asked the librarian to give her library instruction to their classes, using science topics as illustrations.

One day a little freshman came into the library and dumped a green spotted snake on the desk and wanted to know what kind it was. He said a senior told him he could find out in the library. The librarian got the Reptile book and together they looked it thru and compared spots and found the information the boy wanted. The senior knew his library and the small boy has been an ardent patron ever since.

In comparing the different departments in their use of the library, I can safely say the Science holds its own and that the credit the library receives in this connection is merely reflected glory, for it all goes back to the teachers themselves, who are alive, who make known their wants, who so appreciate the library and its resources that they lead their pupils libraryward and thus give us an opportunity to serve them.

Fire Hazards and Safeguards: Suggestions For Ten Lessons *

W. G. WHITMAN, Salem State Normal School.

One very important study relating to heat is that of *fire*. We commonly study about heat applied in useful operations in the household for cooking and heating, while the dangers from fire are given less attention, probably less than they deserve in most cases. The attention now given in the press to Fire Prevention Day, October ninth, each year, helps to enlist the interest of the pupils and connects the subject with practical affairs in life. The lessons as outlined below are intended only as suggestions of what may be done. They are not in all cases complete, but require supplementing with additional material.

When we consider that the fire loss is towards $300,000,000 a year in the United States[1], besides the loss of thousands of lives and that 90 per cent of the fires are due to preventable causes, largely ignorance and carelessness, it seems worth while for the schools to take up the subject in an endeavor to substitute information for ignorance and to impress pupils with the need of reducing carelessness. In this way we may help to remove fire hazards and to increase proper safeguards in the home and the community.

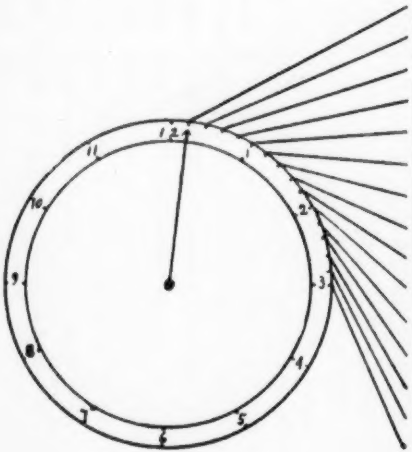
The following series of lessons based largely on laboratory methods has been used with seventh grade pupils, though it is equally well-suited to the eighth or ninth grade.

LESSON I. A STUDY OF REPORTED FIRES: CAUSES.

The teacher should collect a number of newspaper clippings of fires. Select for use those which report *causes* of fires. Make a diagram of a clock dial on the board with a tabulated form at the right for record. This is all done before class time. Discuss with the class the frequency of fires. On an average there are 1500 every twenty-four hours in United States. If equally distributed in time how often would a new fire break out? A little calculation shows that there would be a fire for *every minute* of the day. Pass one of the clippings out to each pupil. Ask them to note *what burned*, the *cause*, the *money loss*, and whether anyone was *killed* or *injured*. Let one pupil take his place at

1 In 1918 the fire loss in the U. S. and Canada was $317,000,000 and 15,000 people were killed.

* Digest of talk and demonstration before the Boston Elementary Teachers' Science Association, Mar. 1920.



Minutes	What Burned	Cause	Money Loss	Persons	
				Killed	Injured
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
Total					

Data from Fifteen Fire Reports.

the blackboard and put an arrow on the clock dial each minute by actual time. This will be the signal for some pupil to report the data from his clipping, while another pupil or the teacher records the data in the tabulated form. Each pupil may keep the records also in his notebook. This may be continued for fifteen minutes. Total the money loss and loss of life. If this average continued for the whole twenty-four hours, what would it amount to? Study the causes of fires. Discuss tnem. Are any due to lack of information or knowledge of the dangers? Are any due to probable carelessness? What part of them could have been prevented by proper precautions? Emphasize *ignorance* and *carelessness* as the cause of the majority of fires and that 90 per cent. of the fires are preventable.

As an individual project, pupils may collect sixty clippings to represent the fires that might occur in one hour. Mount them in notebooks and study the prevailing causes. Find the loss reported and calculate the daily fire loss if the same rate continued.

LESSON II. TO COMPARE THE FIRE LOSSES OF DIFFERENT PLACES.

Pupils will make a graph to show the relative losses in different places as suggested. Let the pupils calculate the length

GRAPH TO SHOW RELATIVE FIRE LOSSES IN DIFFERENT PLACES.

Date	Place	Fire loss per person per year	Graphic representations
1913	Holland	$0.11	
"	Switzerland	0.15	Scale. 1 in. = $1.00
"	Italy	0.25	
"	England	0.33	
"	Grance	0.49	
"	United States	2.10	
1917	Boston	5.27	
"	Lynchburg, Va.	10.42	10.4 in.
"	Kan. City, Kan.	11.25	
"	Lexington, Ky.	11.25	
"	Sioux City, Ia.	11.25	
1912	Houston, Tex.	51.14	
1913	Salem, Mass.	300.00	
....	My own town	......	

of line to represent the fire loss of each place, according to data given; then to draw a heavy line horizontally in the blank space following. Where the length of line would be too long for space, use the device suggested for "Lynchburg." If possible, find data for pupils' own town for some given year. Call attention to the fact that our fire loss is the heaviest of all the countries of the world and that it is increasing six times as fast as our population.

LESSON III. A STREET OF DESOLATION AND ITS STORY.

A Street of Desolation

Draw a line to represent a street which might connect Chicago and New York. Data worked out by the pupils may be recorded along this line. What is the distance in miles, in feet? If the street is lined with houses on both sides, on lots with sixty-foot frontage, how many houses would there be? Charles Whiting Baker says that the fires each year in the United States equal the burning of all the houses on such a street between New York and Chicago, and that "A person journeying along this street of desolation would pass in every thousand feet a ruin from which an injured person was taken; at every three quarters of a mile in this journey he would encounter the charred remains of a human being who had been burned to death." If the damage to each house were $2,000, what money loss would be represented? How many people are represented as injured? As burned to death?

What was the biggest fire ever recorded within one hundred miles of you? Compare with the New York-Chicago street of desolation. If *carelessness* could be entirely removed, what might we expect for a fire loss? What part of the New York-Chicago street would remain lined with homes? What can children do to reduce the number of fires?

Carelessness—Our Great Enemy

WHO AM I?*

I am more powerful than the combined armies of the world.

I am more deadly than bullets, and I have wrecked more homes than the mightiest of siege guns.

I steal in the United States alone over $300,-000,000 each year.

I spare no one ,and find my victims among the rich and poor alike, the young and old, the strong and the weak; widows and orphans know me.

I masacre thousands upon thousands of wage-earners in a year.

I lurk in unseen places, and do most of my work silently. You the warned against me, but you heed not.

I am relentless. I am everywhere; in the home, on the street, in the factory, at railroad crossings, and on the sea.

I bring sickness ,degradation and death, and yet few seek to avoid me.

I destroy, crush and maim; I give nothing, but take all.

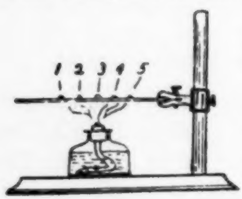
I am your worst enemy

I am CARELESSNESS.

*Roy K. Moulton, in the Grand Rapids, Michigan, "News."

LESSON IV. How Substances Take Fire: Demonstration.

1. *Combustible Substances: Kindling Temperature.* Place small amounts of sulphur, wood, clean sea sand, concrete, and phosphorus (size of half a rice grain) at short distances apart on an iron plate in the order shown in the diagram.



1. Sulphur 2. Wood
3. Sand 4 Concrete
5 Phosphorus

Heat with an alcohol lamp or a low gas flame. We may assume that they are all warmed to the same degree in the same time. The class will watch carefully for results, as *smoking*, *melting*, and *burning*. These should be recorded. If the wood does not burn, try the wood, the concrete, and the sand in a hotter flame. Classify the substances as *combustible* **and** *non-combustible.* Define the *kindling point* as that temperature at which a substance takes fire. Which combustible substance has the lowest kindling temperature? Which the highest? What is necessary to make a substance burn? How do substances vary in this property? Compare wood, sandstone, and concrete as fire-proof materials for building.

The above demonstration also explains the match. The match tip has a low kindling temperature. When this burns it warms the wax to its kindling temperature—and this in turn heats the wood until it burns. A recent news heading was "A $14,000,000 Fire Started with a Match." An entire lesson may

well be given to matches, their uses, manufacture and dangers. What are "safety" matches? Directions for making matches are given in the QUARTERLY for January 1919.

2. *Spontaneous Combustion.* Dissolve a stick of phosphorus half an inch in length in a test tube one-half full of carbon disulphide. Roll a filter paper so that it will slip into the tube. Wet the filter paper with the solution. Unroll and lay on an iron plate. Explain that the carbon disulphide quickly evaporates and leaves the phosphorus in minute particles covering the paper. These small particles oxidize in the air and heat results. The heat may accumulate faster than it is carried away. This is particularly true in this case, since the paper is a poor conductor of heat. As heat accumulates the temperature rises. When the kindling temperature is reached, fire results.

Certain oils, as those used by painters and sometimes found in floor and furniture polishes, oxidize when exposed to the air. Cotton waste and cloth are poor conductors of heat. Explain in detail how a fire may result in the home from spontaneous combustion.

LESSON V. PRINCIPLES OF FIRE EXTINGUISHING.

The requisites of fire are a combustible substance, oxygen, and heat to maintain the temperature at or above the kindling point. A fire will go out if any one of these be lacking. The two most common methods of extinguishing fires are the lowering of the temperature and smothering to exclude oxygen. Water, our most common fire extinguisher has greater cooling effect than any other substance for its weight. What are some other reasons why it is so commonly used? Besides its abundance and ease of handling, some of it is often changed to steam in which form it takes up 1700 times the volume of the water and sometimes this helps to exclude oxygen of the air.

For smothering a small fire a rug or any heavy clothing is useful. The relative merits of materials may be seen by trying to burn cotton, asbestos, and woolen yarn. From this experiment, pupils will see the value of asbestos curtains in theaters and asbestos inclosures for moving-picture machines. They will also see why woolen garments are preferable over cotton for

smothering a flame. The greater efficiency of a wet cloth over a dry one may be shown also. Demonstrate how to extinguish fire in a person's clothing by rolling him in a blanket or rug on the floor.

LESSON VI. HOME AND SCHOOL FIRE EXTINGUISHERS.

1. CARBON DIOXIDE EXTINGUISHER.

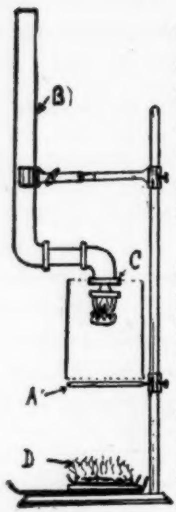
If an empty carbon dioxide extinguisher is available, show its parts. Use a vertical section diagram to explain more fully its structure and operation. The acid acts on the soda to produce carbon dioxide gas. The gas has a twofold purpose—to create pressure, forcing a stream of liquid from the nozzle, and dissolved in the liquid, it is liberated at the fire which it helps to extinguish.

Demonstrations. (a) Light a candle in a glass jar containing a small amount of dilute acid. Drop into this a few lumps of sodium bicarbonate. Result? (b) Arrange six short paraffin candles in an inclined trough. Generate a large battery jar full of carbon dioxide, by mixing acid and soda. Keep the jar closed with paste-board, as it is being generated. Light the candles. Open the jar slightly. Hold the mouth at the top of the trough and pour the gas into the trough. What result indicates its progress down the trough? What two properties of the gas are shown? Repeat (b) after changing the position of the trough so that the trough is nearly vertical. This makes a stronger draft. What different result may occur due to the much stronger convection currents? Explain. Recommend the carbon dioxide extinguisher for home protection.

2. PYRENE AND JOHNS-MANVILLE EXTINGUISHERS.

These extinguishers are charged with carbon tetrachloride (CCl4). Fill an empty extinguisher with water and show how to operate it. Recommend this type of extinguisher for the garage and the automobile.

3. WATER SPRINKLER HEAD.



The majority of school fires start in the basement. Many of them are unseen until too large to control by means of the hand extinguishers. There is available, however, an automatic extinguisher which upon an increase in temperature, such as results from a small fire, will open and send a spray of water in all directions, thus extinguishing the fire.

Demonstration. Place the Sprinkler Demonstrating Set over a sink or place a large heavy paper under it to protect the table top. A large shallow pan will catch most of the water. A small metal dish (D) to hold the fire sets in the larger pan and is separated from it by a thick layer of asbestos. Shreaded asbestos wet with denatured alcohol is placed in the small dish, covering the base to a depth of ¼ inch. "Canned Heat" may be used in its place. A glass cylinder is used to prevent the water from spreading too much. This is supported by the iron ring (A) a few inches above the fire pan. Adjust the elbow (C) to 5 inches above the iron ring. The pipe (B) is filled with water and the fire lighted. The resulting heat quickly opens the sprinkler head and the fire is quenched. The same sprinkler head can be closed and used repeatedly by the use of low melting solder. The entire outfit can be obtained at cost from the General Fire Extinguisher Co., Providence, R. I.

LESSON VII. USING AND CHARGING THE CARBON DIOXIDE EXTINGUISHER.

If the school is supplied with carbon dioxide extinguishers, they need to be recharged once a year. Let these be discharged and recharged by the class under the direction of the instructor. Added interest is secured by having competing groups build small bonfires and let the groups see which can extinguish their fires first, at twenty feet distance. If two and a half gallon extinguishers are used, one and one-half pounds of sodium bicarbonate are dissolved in the water and four ounces of concentrated sulphuric acid used in the acid bottle. Clean the extinguishers well. Strain the bicarbonate solution through

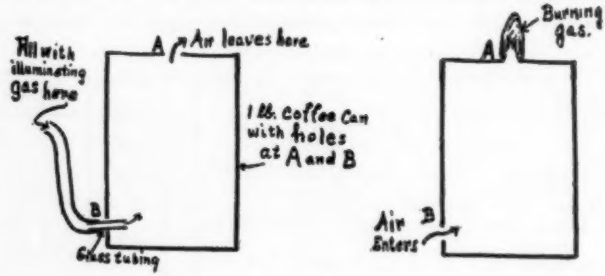
cheese cloth as it is poured into the extinguisher. Use a new gasket and screw the cover on as tightly as possible.

A suggested project is to make a working model extinguisher from a large wide mouthed bottle with a pill vial for holding the acid.

LESSON VIII. INFLAMMABLE GASES AND OILS.

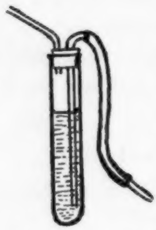
Burning gasoline and oils are particularly difficult to handle. They float on water and, hence, water is seldom of any value. Hot oils and fats are scattered by water and so the fire danger is increased. Gasoline and oils are very easily changed to gases which behave much as illuminating gas does. When this is mixed with air, it is explosive.

Demonstration. (a) *Gas.* Get a one-pound coffee can with a tight fitting cover. Make a hole in the cover rather larger than



a lead pencil and another in the side near the base. Fill with illuminating gas and light at the top. As the gas burns, air enters the gas hole, mixing with the gas. When the mixture has reached about 80 per cent. air, an explosion results. A few drops of gasoline in a warm can will also give an explosion.

Repeat the experiment with the illuminating gas, but place the can over an alcohol lamp to keep the bottom warm and just before lighting it, introduce one to two cubic centimeters of carbon tetrachloride into the bottom of the can by means of a pipette. Why does this give a different result?



(b) *Gasoline.* Fit a test tube with stopper and tubes so that when you blow through one tube, water contained in the tube will be thrown out in a stream through the other. Fit a second tube in the same manner, but fill the tube one-half full of carbon tetrachloride. Set fire to a spoonful of gasoline in an evaporating dish. Direct a stream of water from the test tube into the flaming gasoline. Extinguish by smothering with a wet cloth. Ignite another spoonful of gasoline and direct the stream of carbon tetrachloride into it. How should a kettle of burning oil or fat on the stove be extinguished?

LESSON IX. Home Fire Hazards. Score Cards.

Discuss the various items in the following score card and have pupils score their own home, writing his score for each of the ten units in the column under "allowed."

		Perfect Score	Allowed
1. Fireproof constructions.			
Slate or other fireproof roof	5		
Stone, brick, or concrete walls	5	10	
2. Not nearer than 25 ft. to other wooden buildings		10	
3. Metal ash cans used	5		
Metal pipe gas—no rubber gas connections	5	10	
4. Matches.			
Safety matches used	5		
Out of reach of children	5	10	
5. (a) No swinging gas jets or lamp brackets near curtains (10).			
(b) Oil lamps of metal, low, not easily upset (10). Score either (a) or (b)		10	
6. No one in family is careless with fire	5		
No smokers in family	5	10	
7. No stove pipe through wall of floor	4		
No stove within 1 ft. of unprotected wall	3		
Metal or asbestos mat under stove and extending 10 in. in front	3	10	
8. No gasoline kept in glass bottle	3		
No gasoline used for cleaning indoors	3		
Kerosene never used in kindling fire	4	10	
9. No rubbish allowed to collect	4		
No oily rags collect or left	3		
No celluloid articles in house	3	10	
10. Have a hand fire extinguisher	4		
Fire engine house within ¼ mile	4		
Hydrant within 300 ft. of house	1		
Fire alarm box within 500 ft. or have a telephone	1	10	
Total...			

LESSON X. FIRE PROTECTION BY A COMMUNITY.

This lesson may consist of reports on "A Visit to the Fire Engine House." If desired, it may be expanded to a number of lessons in which some of these topics are explained:

1. City water system for fire protection—hydrants, reservoirs, etc.
2. City fire alarm system.
3. The fire engine—steam engine and double acting pump.
4. The chemical.
5. The hook and ladder truck.
6. Fire nets, pulmotors, and other fire fighting equipment.
7. Motor vs. horse equipment.
8. Fire traffic regulations.
9. City fire ordnances and building restrictions.
10. Fire insurance. Why rates vary.

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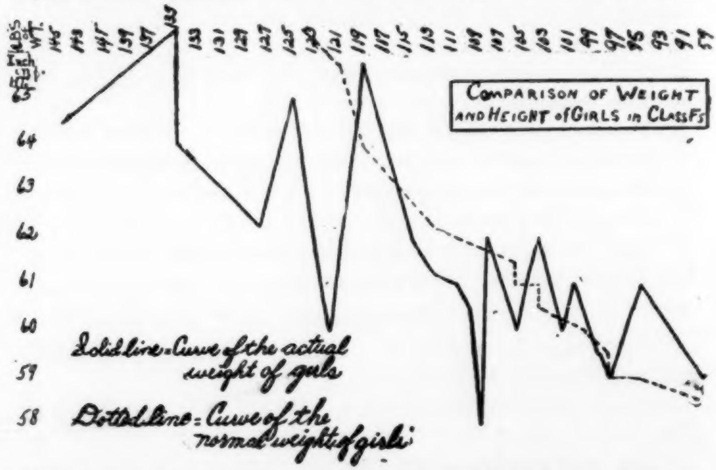
Health and a Happy New Year

ELIZABETH BAYER AND BERTHA MAY CLARK, William Penn High School, Philadelphia.

It is significant that the Red Cross Seals for Christmas 1919 bore the message "Health and a Happy New Year." Some kind of health instruction has always been a part of school work but interest and propaganda by a national and international organization gives to all health movements a boom and encourages needed reconstruction in the class room. One aim of general science is to interpret as much science material as possible from the view point of health and thus to give prominence to high health standards; and another aim is to develop in the pupils the idea that health is a matter of personal responsibility to the community.

The real and difficult problem before the teacher is the presenting of health instruction in so invigorating and forceful a way, that will have a vital reaction and reform in the daily habits of the pupils. The very simple health scores put out by the Red Cross for small children suggested a daily ques-



tionnaire for high school students that might rouse them to apply the physiology lessons thoroughly learned in the grammar school but stored away for neither present nor future use. Only the most elementary and important personal habits that are constantly neglected were selected for observations extending over a month. Some important details omitted from the chart may readily come to mind, but the importance of this chart is in its performance by the pupil and the daily reminder to him of his defects and backslidings.

At the end of the month the score cards are brought to school, the health standard of each item on them is discussed and a comparison is made with a norm. This line is drawn horizontally across the middle of the graph paper. The normal for sleep was taken as 9 hours per day; for exercise, one hour in the open; for food, 3 regular well chewed meals; one teeth cleaning and for baths, two a week, either tub or sponge.

The scale used represents the units of measurement uniformly adopted by the class. Thus 2 squares stand for one inch above or below normal in height, for 2 pounds above or below normal in weight, for ten minutes in exercise, and for one

CHART I. **Pupil's Score Card.**

Name .... Date .... Age ....

HEIGHT .... Normal weight for age .... Normal height for weight ....

WEIGHT .... Normal height for age .... Normal weight for height ....

Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Hrs. *sleep* per day																												
Min. *outdoor exercise*																												
No. of regular *meals*																												
No. of times *teeth* are *cleaned*																												

1st. wk. 2nd. wk. 3rd. wk. 4th. wk.

BATHS: No. of sponge or tub baths per week ....

TEETH appearance; excellent.......... good .... fair .... poor ....

Postion of visible cavities ....

Date of last visit to dentist ....; date of filling of cavities ....:

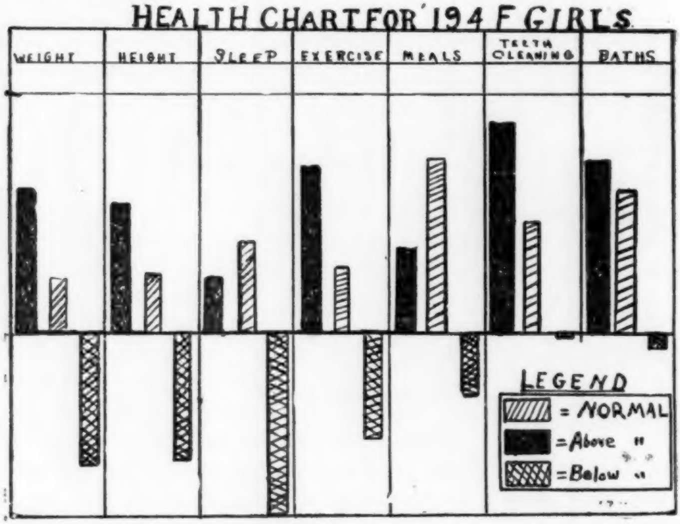
HAIR appearance ....; frequency of washing per year ....

NAILS. Evidence of biting........; times cleaned per week........; how cleaned.........................

SLEEPING QUARTERS. No. of windows in room........; arrangement at night...........................

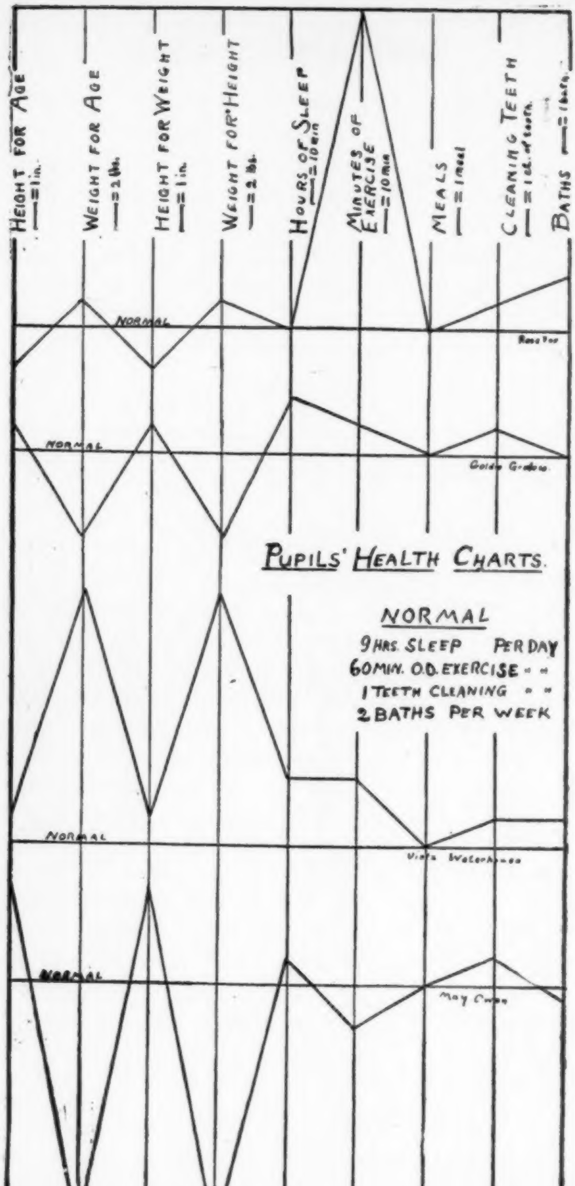
meal, one teeth cleaning, and one bath. Some of the norms seem low, for example one teeth cleaning per day, but these were adopted as the most suitable under the conditions represented in this school. For obvious reasons many results concerning teeth cleaning and bathing are unreliable. The comparison of their data with a norm is valuable to the pupils in making them realize that there are standards for daily habits; the project as a whole awakens them to the need of definite habits and routine for efficient living and prepares them for considering and devising an hygienic daily routine for themselves.

These personal records of the 194 pupils are then further compounded in smoke stack form to show ratings for the entire group.



Smoke Stack Graph.

A chapter summary in an elementary school physiology gave the idea for the following Bad Habits Chart. It tells the pupils nothing new, but rather says old things in a different way. When the pupil sees how he looks on paper, a picture not presented by the mirror—this visual presentation carries greater conviction than class room drill. The mathematical evaluation further speaks with definite and uncompromising forcefulness. Similar scores or mathematical rating of various factors of



HEIGHT FOR AGE
WEIGHT FOR AGE
HEIGHT FOR WEIGHT
WEIGHT FOR HEIGHT
HOURS OF SLEEP
MINUTES OF EXERCISE
MEALS
CLEANING TEETH
BATHS
NORMAL
NORMAL
NORMAL
NORMAL
PUPILS' HEALTH CHARTS.
NORMAL
9 HRS. SLEEP PER DAY
60 MIN. O.D. EXERCISE " "
1 TEETH CLEANING " "
2 BATHS PER WEEK

the pupil's environment, namely home, school, grocery store, and meat shops, send them on tours of inspection, acquaint them with sanitary requirements of the city and state, and present actual conditions of health and living in their community and state.

A sanitary survey of their wards may be made, marking unsanitary places in black, sanitary ones in red, in order to give at a glance a general notion of neighborhood conditions. By this exercise, the young citizen sees on every hand, the general violation and non-enforcement of laws and is vitally impressed with the importance for individual responsibility and co-operation. The "spirit" of the hive as a necessary factor in our democratic environment here finds potent expression and the emotion is stirred for a citizenship of the higher order of the Athenian,—"In all ways we will transmit our city greater, better, and more beautiful than it was transmitted to us."

In order to get across, some of the simplest rules of personal and community health, and to have them function the next day or the following week, does it not require science experiments rather than civic instruction which always begins with health as the problem of first importance to a community? Is it not necessary to plant and grow bacteria and count the increasing colonies in order to really understand why the hands should be washed before eating or why spitting is dangerous? When the factors incident to feeding the baby with cow's milk are seen as millions of powerful disease germs, then "Save the babies" campaigns will be really understood and reform will be easy and immediate. Similarly, when the life history of insects are studied, and the weak parts appear as keys to their control, then the dangers of manure piles for flies and typhoid, and swamps for mosquitoes and malaria become imminent, and public co-operation is hearty because intelligent. If studies in birds, fish, and flowers, present the details of universal care for the young among plants and animals, then mother love and parental care are seen not merely as something beautiful in human society, but as a necessary function for living things, and a paramount duty of the individual in human society, where childhood is the longest and most helpless. This scientific background of facts and ex-


BAD HEALTH HABITS
Biting Finger Nails
Licking Fingers To Turn Pages
Putting Lead Pencil In Mouth
Licking Fingers
Kissing On The Mouth
Spitting
Drinking From Public Cups
Picking Teeth
Chewing Gum
Eating Exposed Food
Eating Without Washing Hands
Drinking Water In Strange Places
Picking Nose
Coughing Without Covering Mouth
Careless About Avoiding People With Cold
Sneezing Without A Handkerchief
Carelessly Allowing Handkerchiefs To Lie Around
Bad Standing And Sitting Position
Picking Ears With Hair-pins
Wearing Heels That Are Too High
Wearing Shoes Too Small And Too Pointed
Daily Neglect Of Constipation
Picking Scabs
Careless About Scratches And Cuts
Sleeping With Closed Windows
GENERAL AVERAGE OF CLASSES
F1 15%
F3 19%
F4 22%
F6 20%
F7 23%
"EVERY SICK MAN IS A RASCAL

periments that give real reasons, is the only way to produce a reaction of intelligent, active, and eager co-operation in civic affairs where now inertia and opposition exist.

It was the great Pasteur who showed that health is not a matter of the Lord's will but a thing of our control and responsibility—usually a stand-up fight to our environment. Generally speaking, to-day, we agree with Samuel Johnson "Every sick man is a rascal." As teachers, it is our purpose and duty to explain and present some of the simple health truths expressed long ago and in other tongues "*Know thyself*," "*In Sano Corpore Sans Mens.*" To this forward movement, of the Red Cross, for a health crusade we must contribute. We must do more than extend wishes for health and a happy New Year. We must help to make that wish come true.

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Talks over beams of light. Pop. Mech. 32:811. Dec. 1919.

THUNDER STORMS
Thunder Storms in the Making. Ill. Rogers D. Rusk. Pop. Mec. 33:1:30-1. Jan. 1920.

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The home tool box. Ill. Henry Simon. Ill. World. 32:609-612. Dec. 1919.

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Pay-dirt in city streets. Lit. Dig. 63:9:24-25. Nov. 29, 1919.

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The romance of the trees. Ill. E. H. Wilson. Gar. Mag. 30: 90-95 and 144-148. Oct. and Nov. 1919.

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American City. The Tribune Building, N. Y. C. Monthly. Two editions. City and Town and County Editions. $3.00 a year, 35c a copy. The Science problems of city and rural communities are treated in numerous articles, well illustrated. A valuable student and teacher's reference.

American Forestry. Washington, D. C. Monthly. 25c a copy, $3.00 a year. Splendid pictures for plant and tree study.

Commercial America. Phila. Com'l Museum, Phila., Pa., $2.00 a year. Ill. Commercial production. New Inventions. Will interest Commercial geography and science teachers.

Current Opinion. 65 W. 36 St., N. Y. Monthly. 25c a copy, $3.00 a year. Has a regular department "Science and Discovery" containing articles of popular interest, adapted to pupil or teacher's use.

Country Life, The New. Garden City, N. Y. Monthly. 50c a copy, $5.00 a year. Stands at the head of publications dealing with life in the country. Special interest to the general reader and has many articles on gardening and plant study valuable for school use.

Electrical Experimenter. 233 Fulton St., N. Y. Monthly. 15c a copy, $1.50 a year. Ill. Popular articles on electrical subjects which fascinate elementary and high school pupils. Many suggestions for teachers.

Everyday Engineering Magazine. 33 W. 42 St., N. Y. Monthly. 20c a copy. $2.00 a year. Ill. Popular articles on science and mechanics. Much of it is simple enough for elementary pupils.

Garden Magazine. Garden City, N. Y. Monthly. 25c a copy, $3.00 a year. Ill. Helpful to amateur gardeners, teachers and pupils.

General Science Quarterly. Salem, Mass. Quarterly. 40c a copy, $1.50 a year. The only journal published devoted alone to science in the elementary and secondary schools. It tells what schools are doing in science, gives lesson plans, demonstrations, and an extensive bibliography of usable articles in current periodicals.

The Geographical Review. Broadway at 156th St., N. Y. 50c a copy $5.00 a year. Devoted to scientific geography. Original maps and pictures. One department contains condensed items on topics of current interest.

Good Health. Battle Creek, Michigan. Monthly. $2.50 a year, 25c a copy. Reduced rate to Schools. A non-technical health magazine devoted to race-betterment and biologic living.

The Guide to Nature. Sound Beach, Conn. Monthly. 10c a copy, $1.00 a year. Ill. Of interest to elementary pupils and teachers of nature study.

Illustrated World. Drexel Ave. and 58th St., Chicago. Monthly. 20c a copy, $2.00 a year. Many short articles on applications of science and mechanics. Popular in style and attractive to elementary and high school pupils.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, $5.00 a year. Ill. A technical journal. Contains many articles of value to science teachers.

Journal of Home Economics. 1121 Cathedral St., Baltimore. Monthly. 25c a copy, $2.00 a year. For teachers.

The Literary Digest. 354 Fourth Ave., N. Y. Weekly. 10c a copy, $4.00 a year. Has a department "Science and Invention." Articles are mostly digests from other journals. They are popular in nature and suitable for high school pupils.

Transplanting big trees. Ill. E. S. Draper. Gar. Mag. 30: 132-4. Nov. 1919.
When trees grow. Ill. J. S. Illick. Am. For. 25:1386-1390 Oct. 1919.
Central Park trees starving to death. Ill. C. L. Park. Am. For. 25:1391-1400. Oct. 1919.
The Cedar of Lebanon. Ernest H. Wilson. Gar. Mag. 30:178-183 Dec. 1919.
The Glory of the Redwoods Threaten by Fire. Ill. M. B. Pratt. Am. For. 25:1443-5. Nov. 1919
California's Redwood Park. Ill. A. A. Taylor. Am. For. 25:-1446-50. Nov. 1919.
Twisted Trees. Ill. Enos Mills. Country Life. 37:3:58-9. Jan. 1920.
Memorial Trees In 1920. Ill. Am. For. 25:1537-52. Dec. 1919.
The Romance of our Trees: The Yew. E. H. Wilson. Gar. Mag. 30:213. Jan. 1920.
The Romance of our Trees: The Horse Chestnut. E. H. Wilson. Gar. Mag. 30:267. Feb. 1920.

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Binder Twine From the Desert. Illus. John L. von Blon. Sc. Am. 121:82. July 26, 1919.

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Measuring visibility. Sc. Am. Suppl. 88:279. Nov. 8, 1919.

VITAMINES
The Present Status of Vitamines. Blunt and Wang. Jo. Home. Econ. 12:1-14. Jan. 1920.

WAR
Our Technical Achievements in the Great War (Many diagrams) Sc. Amer. 121. A series of articles beginning Aug. 2, 1919 and continuing several months.

WASTE
Bibliography on Waste Utilization as affected by the War. Jo. Ind. & Eng. Chem. 11:1171. Dec. 19, 1919.

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Relative Sanitary Value of Different Types of Drinking Fountains. Ill. Louis V. Dieter. Am. City 31:452 and 549. Nov. & Dec. 1919.
The Color of Water. W. D. Bancroft. Sc. Am. Sup. 87:374. June 14, 1919 and continued in subsequent numbers.

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Power from Tidal Waters. Sc. Am. Sup. 88:201. Sept. 27, 1919.

WATER SUPPLY
Relation of a Private Well to Typhoid. Harry E. Barnard. Am. City. 20:550-553. June 1919.
Softening a Municipal Water Supply for Domestic Use. H. H. Bristol. Am. City. 20:554-555. June 1919.
Safe-Guarding Municipal Water Supplies by Tree Growth. Paul D. Kelleter. Am. City. 20:556-559. June 1919.

Journal of Industrial and Engineering Chemistry. Box 505, Washington, D. C. 60c a copy, $6.00 a year. A technical journal which contains much material which teachers can use. Monthly.

National Geographic Magazine. Washington, D. C. Monthly. 25c a copy, $2.50 a year. Best monthly journal for high grade pictures. Articles are of interest to general reader, pupils and teachers, as well as to geographers.

Nature Study Review. Ithaca, N. Y. Monthly. 15c a copy, $1.00 a year. An illustrated journal for teachers of nature study.

Physical Culture. 119 West 40th St., N. Y. C. Monthly. $2.00 a year, 20c a copy. Popular articles on health and physical development.

Popular Mechanics Magazine. Chicago. Monthly. 20c a copy, $2.00 a year. Short science items and articles well illustrated. Appeals strongly to elementary pupils. Suggest many construction projects.

Popular Science Monthly. 255 West 39th St., N. Y. C. Monthly. $2.00 a year, 20c a copy. A Review in text and pictures of the news of science and invention presented in a humanistic and inspirational way. Used as a supplement to text-books in many high schools. Valuable to science pupils and teachers.

Review of Reviews. 30 Irving Place, N. Y., N. Y. Monthly. $4.00 a year. An illustrated monthly covering world affairs. Contains many good articles bearing on science, suitable for class reports.

School Science and Mathematics. Chicago. Monthly. $2.50 a year. A teacher's journal. Includes many helpful suggestions.

Scientific American. Woolworth Building, N. Y. Weekly. 10c a copy, $5.00 a year. Has longer articles than the other popular science journals. Illustrated and is particularly valuable to high school science pupils and teachers.

Scientific American Supplement. Woolworth Building, N. Y. Monthly. 40c a copy, $4.50 a year. Rather technical, but the majority of articles are usable by science teachers and some of them will do for pupil reference. Illustrated.

Scientific Monthly. Garrison, N. Y. 30c a copy, $3.00 a year. Articles as a rule are more along lines of pure science. Much of value to teachers. Articles can be read to advantage by many pupils.

Transactions of the Illuminating Engineering Society. 29 W. 39th St., N. Y. Monthly. 75c a copy, $5.00 a year. Technical. Many articles contain material which can be used in high school classes.

Woman's Home Companion. 381 Fourth Ave., N. Y. C. Monthly $2.00 a year. Good articles on foods and homes.

WATER-WORKS
Engines for Small Water-works. Ill. Henry A. Simonds. Am. City (T. & C. Ed.) 21:311-317. Oct. 1919.

WATT
The James Watt Centenary. Illus. H. T. Wade. Sc. Am. 121:206. Aug. 30, 1919.

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Deepest Well in the World. Geog. Rev. 7:417. June 1919.

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Wireless Telephony. Ill. N. H. Slaughter. Jo. Fr. Inst. 189:1-24. Jan. 1920.
A Wireless Storm Detector. Ill. H. T. Wade. Sc. Am. Sup. 1:18-21. Jan. 1920.
The Continental Code. Ev. Eng. Mag. 8:1:30. Oct 1919.
Wireless control of boats and air craft. The art of Telautomatics. Nikola Tesla. Elec. Exper. 7:506. Oct. 1919.
Radio problems in aviation. Ill. E. R. Doyle. Elec. Exper. 7:543. Oct. 1919.
Experimental wireless telegraphy and telephony. Pacent and Lescarboura. Sc. Am. Sup. 88:272. Nov 8, 1919.
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Wood used in Cooperage Industry. Illus. Hu Maxwell. Amer. For. 25:1208-1216. July 1919.
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WOOL
Where Wool Comes From. Ill. J. J. Macfarlane. Com'l. Amer. 15:11:29. May 1919.

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X-Rays in Medical Science. A. C. Jordon, Sc. Am. Sup. 88:391. Dec. 27, 1919.
What the X-rays show. Elec. Exp. 7:510. Oct 1919.
X-Ray Experiments. Illus. Ivan Crawford. Elec. Exp. 7:319. Aug. 1919.